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ABSTRACT

One hundred twelve college students participated in a study designed to determine whether students differ in their relative employment of knowledge-based processes in discourse processing and whether individuals tend to be more "text-bound" and less able to use preexisting knowledge schemata when they are more "stimulus-bound" in a task with analogous processing demands (i.e., an embedded figures test or EFT). Subjects were randomly assigned to read either a narrative about a trip to a restaurant or a parallel narrative about a trip to a supermarket; they then took the EFT and a vocabulary test, after which they recalled the passage they had read. Previous research had shown that, since the "foods purchased" component of the restaurant schema is more highly constrained than that of the supermarket schema, the former supports greater food item recall. Analysis of the results showed that high and low EFT scorers (with variability attributable to difference in verbal ability statistically removed) recalled food items equally well from the supermarket passage but that for the restaurant passage, food item recall increased radically compared to the supermarket passage only for the higher EFT scorers. It was concluded that the low EFT scorers were unable to capitalize on their prior knowledge to increase their recall of information from text. (GT)

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CENTER FOR THE STUDY OF READING

Technical Report No. 111

INDIVIDUAL DIFFERENCES IN SCHEMA UTILIZATION
DURING DISCOURSE PROCESSING

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Abstract

Discourse processing involves an interaction of text-based and knowledge-based processes. It was hypothesized that college students would differ in their relative employment of knowledge-based processes, and that individuals will tend to be more "text-bound" when they are more "stimulus-bound" in another task with analogous processing demands (i.e., an embedded figures test, EFT). Extent of knowledge-based processing (or schema utilization) was assessed by comparing recall of food items from a narrative about a trip to a fancy restaurant with that from a parallel narrative about a trip to a supermarket. Previous research has demonstrated that, since the "foods purchased" component of the restaurant schema is more highly constrained than the equivalent component of the supermarket schema, the former supports greater food item recall. As predicted, food item recall was significantly positively correlated with EFT residuals (after predicting EFT from vocabulary test scores) for the restaurant condition, with an absence of correlation for the supermarket control. Other dependent measures yield the same pattern of positive correlation with EFT or absence of correlation with EFT as a function of whether performance would be enhanced by schema utilization or not, respectively.

Individual Differences in Schema Utilization
During Discourse Processing

Two trends have distinguished the past decade of research in what was once called "verbal learning." First, a concern for ecological validity has led to increasing study of connected discourse, rather than isolated verbal materials such as word lists. Earlier experimental psychologists sought to reduce variability of response across individuals by simplifying stimulus materials and abstracting them as much as possible from verbal material encountered in everyday life, thereby increasing experimental control over mental activities. Second, the theoretical characterization of language comprehension and recall has become increasingly constructive. That is, discourse processing has been shown to rely heavily on an interaction between explicit information in text and the pre-existing knowledge schemata of the processor (cf. Anderson, 1977; Spiro, 1977).

What is striking is that these developments have not led to a greater concern for individual differences in psycholinguistic research. It appears obvious that the use of more meaningful and personally relevant connected discourses as stimuli would increase the potential for differences in individual approaches. Furthermore, a strong possibility of individual differences seems to be a natural corollary of the constructive view, which stresses the nonmechanistic contributions of personal knowledge to comprehension and recall. However, with the exception

of a few studies demonstrating effects of differing backgrounds on text interpretation (e.g. Anderson, Reynolds, Schallert, & Goetz, 1977), the approach of researchers in the constructive paradigm has been almost exclusively nomothetic.

The present research addressed the question of whether skilled discourse processing proceeds in essentially the same way for all individuals. The constructive orientation, which posits a process of active interaction between information explicit in text and information contained in pre-existing knowledge structures or schemata, served as a point of departure in the search for differences in discourse processing style. It is important to note that some flexibility is frequently permitted in the relative contributions of the components of interactive processing; i.e., in some situations one can compensate for schema-based processes by relying more on text-based processes and vice versa. For example, in remembering text one can primarily use the text's structural organization as a mnemonic (Meyer, 1975) or, alternatively, the stable schemata for the topic at hand can be relied on as a scaffolding to facilitate recall (Anderson, Spiro, & Anderson, 1978).

The present hypothesis, then, was that one source of style differences in skilled discourse processing would be related to biases in the extent to which one utilizes knowledge schemata. Furthermore, it was predicted that greater reliance on schema-based processes would be evinced by those who, in other situations, demonstrate

abilities analogous to those required for applying schemata to text. In particular, a task was needed that would parallel the discourse processing requirements of operating with two structures simultaneously or in succession (a text structure and a knowledge structure), where one of the structures must be fit from memory onto the structure of physically present text. Embedded figures tests (EFT), which require detection of a memorized target shape embedded in a complex line and shading configuration, appeared to capture the desired processing characteristics parallel to schema-based processing. The prediction was that high scorers on the EFT, who are better able to appropriately superimpose a structure from memory upon a stimulus structure, would demonstrate greater use of pre-existing knowledge schemata in a discourse processing task. Encouraging previous research can be found in the learning of isolated verbal materials (e.g., word lists), where EFT tends to be positively correlated with the extent to which pre-existing knowledge categories are used to restructure stimulus materials (Goodenough, 1976).

To provide a measure of the extent of schema-based processing, a task developed by Anderson, Spiro, and Anderson (1978) was employed. They had subjects read a passage about a trip by a couple to either a fine restaurant or to a supermarket. The supermarket passage was constructed to closely parallel the restaurant narrative sentence by sentence. In each passage the same food items were mentioned. However, in the restaurant case, the foods were drawn from categories for a fancy meal

that were found in an earlier norming study to be common knowledge for the subject population (e.g., before-dinner drink, appetizer, salad, etc.). Although everybody knows you buy food at a supermarket, the specific types of foods purchased on a given trip are not nearly as constrained as the types one will get in a restaurant meal. The primary result of the experiment was that subjects recalled more of the food items from the restaurant story, which corresponded to a more highly constrained or articulated "foods purchased" knowledge schema, than they did from the supermarket story. The conclusion drawn was that individuals use their knowledge schemata as a "scaffolding" to help them remember information from text.

The primary prediction in the present study was that there would be a greater difference between restaurant (greater schema-relevance) and supermarket (lesser schema-relevance) food item recall for those who score higher on the EFT. Looked at another way, EFT should be correlated more highly with food item recall in the restaurant than in the supermarket condition, since the pre-existing knowledge schema would serve as an efficient scaffolding in the former but not in the latter case.

Method

Participants

One hundred twelve introductory educational psychology students participated to fulfill a course requirement. They were randomly assigned to the supermarket or restaurant condition, 58 to the former and 54 to the latter. Participants were run in groups of 10 to 20.

Materials and Procedure

The passages from the Anderson et al. (1978) study were used. The restaurant and supermarket narratives mentioned the same 18 food and beverage items. Each item was a member of one of the categories identified in the Anderson et al. norming study (e.g., a shrimp cocktail is in the appetizer category). The order of mention of the food and beverage items was identical in the two passages; it matched the order in the restaurant schema as revealed by the norming data. The two passages were very similar in every respect. All of the actors and most of the actions and objects were the same. Events and objects were described in the same order.

Participants were instructed to read their assigned passage and were informed they would later be asked questions about what they read. After finishing the passage, the Group Embedded Figures Test (GEFT; Oltman, Ruskin, & Witkin, 1971) and the Wide Range Vocabulary Test (French, Ekstrom, & Price, 1963) were administered. Administration times for the two tests were 12 and 9 minutes, respectively. Following the vocabulary test, the participants were instructed to recall the passage they had read in as detailed fashion as possible. They were allowed as much time as they needed to complete their recall. They typically finished in 10 minutes or less.

Results

To remove variability attributable to differences in verbal ability, simple linear regression was used to predict GEFT scores from vocabulary test scores. The analyses below are based on residual scores, i.e., the difference between actual and predicted GEFT scores. The correlation between GEFT and vocabulary was small ($r = .13$), and the same results obtain if unresidualized GEFT scores are used.

The primary results are presented in Figure 1. High scorers on the GEFT-residuals ($\frac{1}{2}$ S.D. above the mean; $n = 21$ and 23 for the supermarket

, Insert Figure 1 here

and restaurant conditions, respectively) showed a substantial scaffolding effect, increasing recall of food items from 36% to 60%. Low GEFT scorers ($\frac{1}{2}$ S.D. below the mean; $n = 18$ and 13 for the supermarket and restaurant conditions, respectively) did as well as their higher-scoring counterparts on the supermarket control passage (36%). However, for the restaurant passage, which could be related to a more highly articulated "foods purchased" component in prior knowledge, there was virtually no increase in recall of food items (40% recalled). The difference between supermarket and restaurant recall was significant for the high GEFT-residual scorers [$t(34) = 2.4$, $p < .015$, one-tailed], with no difference between the conditions for the low GEFT scorers ($t < 1$).

Looked at another way, there was a significant amount of additional variance accounted for by predicting food item recall from GEFT residuals using separate regression equations for the restaurant and supermarket

conditions, rather than a single regression equation combining both conditions [$F(1,108) = 3.98$, $p < .05$ for the condition X GEFT-residuals interaction]. There was a significant positive slope of the regression equation for restaurant [$r(56) = .33$ between GEFT residual and food item recall, $p < .02$], and an effective slope of zero for supermarket [$r(52) = .02$].

The overall regression equation was:

predicted food item recall = .162 (Condition; 0 for supermarket and 1 for restaurant) - .001 (GEFT-residual) + .019 (Condition X GEFT-residual) + .365

with multiple $R = .45$ [$F(3,108) = 9.12$, $p < .001$]. The regression weight for Condition was significant [$F(1,108) = 18.59$, $p < .001$] and that for GEFT-residual was not ($F < 1$). As indicated earlier, the interaction regression weight was significant. A Johnson-Neyman (1936) analysis indicated that the two regression lines (one for each condition) differed significantly ($\alpha = .05$) for individuals whose GEFT-residuals were greater than -3.4 (80% of the present sample).

Although females received slightly lower GEFT scores than males (means of 12.5 and 13.0, respectively), the same interaction pattern obtained for both sexes. Looking at extreme GEFT groups (less than 11 and greater than 17), mean proportion of food items recalled for the restaurant and supermarket conditions, respectively, was .22 and .26 for low GEFT males, .44 and .39 for low GEFT females, .56 and .24 for high GEFT males, and .66 and .41 for high GEFT females.

Another measure of schema utilization is the accuracy of attribution of food items purchased or ordered to the right story character. Correct attribution is more important within a restaurant schema than within a supermarket schema. For example, in a restaurant it matters who orders the roast beef, since that person will probably be eating it. It matters less which party throws the roast beef in the shopping cart since it will probably be shared at a later meal. The measure used was the number of food items correctly recalled and attributed divided by the number of food items correctly recalled and either correctly or incorrectly attributed. This measure controls for amount recalled and excludes recalled food items not attributed to somebody. The correlation of attribution and GEFT-residual was .27 for the restaurant condition ($p < .05$ with 56 degrees of freedom) and .06 for the supermarket condition. Again, extent of schema utilization appears to be related to GEFT.

Finally, there were eleven parallel idea units that judges in the Anderson et al. (1978) study deemed equally insignificant in the restaurant and supermarket schemata. Recall of these idea units did not differ by condition, with means of 3.7 and 4.0 for the restaurant and supermarket conditions, respectively ($t < 1$). More importantly, recall of these idea units was not correlated with GEFT-residual for either condition ($r = .10$ for restaurant and $r = -.06$ for supermarket). This result lends further support to the claim that effects related to GEFT are specifically due to differences in schema utilization rather than a general recall superiority of high GEFT individuals.

Discussion

Successful performance on an embedded figures test requires a freedom from Gestaltbindung (Thurstone, 1941), an ability to overcome the perceptual resolution of a stimulus configuration in order to detect the presence of a target structure retained in memory. Somewhat analogously, successful discourse processing requires that an individual not rely exclusively on the "stimulus configuration" of that situation, i.e., the explicit structure and content of the text as presented. Rather, one must detect the relevance and applicability of pre-existing knowledge schemata and superimpose those structures on the text in interaction with the text's inherent structure. The question posed, then, was whether individuals who appeared "stimulus-bound" on an EFT would also be overly "text-bound" on a discourse processing task.

The hypothesis was confirmed in striking fashion. Low and high EFT scorers (with verbal ability statistically removed) recalled food items equally well from the supermarket passage, for which the underlying "foods purchased" schema component is not highly constrained. However, for the parallel restaurant passage, with its finely articulated "foods purchased" schema component, food item recall increased radically compared to the supermarket passage only for the higher EFT scorers. For those with EFT residuals one half standard deviation above the mean the improvement was considerable. Low scorers on the EFT recalled equally many food items in both passages. Furthermore, attribution of food items to

characters was positively correlated with EFT when attribution was schema-relevant, with an absence of correlation when attribution was not schema-relevant. In this experiment the low EFT subjects were unable to capitalize on their prior knowledge to increase their recall of information from text, while not manifesting a general inferiority compared to high EFT scorers (given equal performance on the supermarket passage, as well as on the equally schema-relevant parallel ideas).

An important caveat: the inference should not be drawn that low EFT scorers can not or do not use their prior knowledge to process text. Given the plethora of demonstrations that one must use knowledge other than that embodied in text to form minimally acceptable understandings (see Spiro, in press), it seems quite unlikely that the low EFT college students could have progressed as far as they have educationally without considerable employment of "top-down" processes. Rather, the use of prior knowledge to help one remember better is somewhat optional; one can use knowledge to enrich understanding without necessarily gaining mnemonic benefits. Furthermore, low EFT scorers may be superior to high EFT scorers in other aspects of discourse processing. For example, they may be better at capitalizing on the inherent structure of text to improve recall. Since the supermarket and restaurant passages had the same text structure, one would then expect equivalent performance in both conditions.

Finally, given the clear-cut individual differences between skilled discourse processors in the present experiment, might it not be reasonable to expect even greater heterogeneity of reading style among children

who are having reading comprehension difficulties? Whereas skilled readers may differ in their relative employment of text-based and knowledge-based processes when flexibility is permitted, perhaps the less skilled reader is over-reliant on one type of process. For example, a reader with decoding problems might try to escape by relying on knowledge-based guesses in place of decoding or focus too much attention on decoding, thereby creating a bottleneck that inhibits knowledge-based processing. Evidence of patterns of over-reliance on text-based or knowledge-based processes were found in a recent study by Spiro and Smith (Note 1). Several reading tasks were developed with the characteristic that poor performance on a given task would be indicative of over-reliance on either text-based or knowledge-based processes. Considering performance of individual third graders across tasks, both types of over-reliance patterns were found to occur at greater than chance levels. However, far fewer children than would be expected by chance (only one child out of 48) demonstrated over-reliance on text-based processes on some tasks and knowledge-based processes on others. In other words, where performance was poor on more than one task, the overwhelming tendency was for breakdowns to represent only one type of over-reliance. The Spiro and Smith results, taken together with those of the present study, argue for unidirectional biases in the relative contributions of text versus knowledge to interactive discourse processing as an important style dimension in adults and children.

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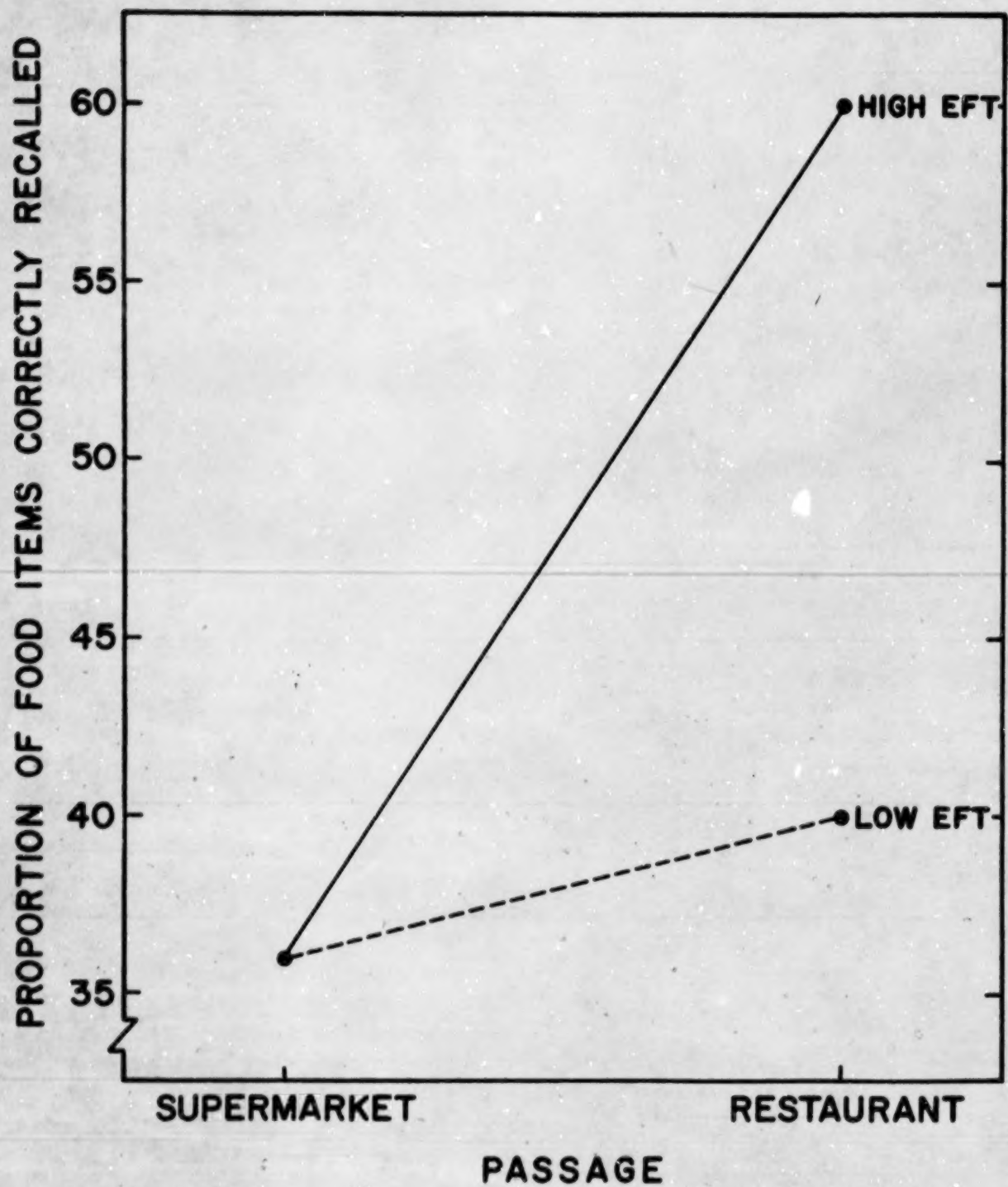
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Footnote

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Figure Caption

Figure 1. Food item recall as a function of EFT-residuals and passage.



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